REMARKS

Claims 1-22 are pending in the present application. With entry of this Amendment, Applicant cancels claims 1-22 without prejudice and adds new claims 23-58. Reexamination and reconsideration are respectfully requested.

Objection to the Specification

The Examiner objected to the specification at page 10, line 7 based on the word "eybrow." Applicant has amended the specification at page 10, line 7 to correct the informality. Applicant has further amended the specification at page 6, line 14 to correct another informality. No new matter has been added.

Rejections Under 35 U.S.C. §§ 102, 103 and 112

The Examiner rejected claims 21 and 22 under § 112, second paragraph. The Examiner rejected claims 1-7, 12-17, 21 and 22 under § 102(e) as being anticipated by Prokoski (U.S. Patent No. 7,027,621 B1). Claim 8 was rejected under § 103(a) as being unpatentable over Prokoski in view of Yeo (U.S. Patent No. 6,130,617). The Examiner rejected claims 9 and 18 under § 103(a) as being unpatentable over Prokoski in view of Molander (U.S. Patent Pub. No. 2004/0247183 A1). Claims 10, 11, 19 and 20 were rejected under § 103(a) as being unpatentable over Prokoski in view of Shiffer et al. (U.S. Patent No. 6,924,832 B1).

Applicant has canceled claims 1-22 without prejudice. Accordingly, Applicant respectfully submits that the above rejections are now moot.

New Claims 23-58

The present invention is directed to a method and apparatus for monitoring a biological process such as drowsiness. Conventional methods for detecting drowsiness employ shape-detecting means to determine the shape of a person's face at a given time. Such methods have a

number of limitations. First, they require heavy computation. Second, such methods only detect a shape and do not provide a useful signal for measuring behavior.

The present invention overcomes these limitations in at least two ways. First, to reduce computation overhead, the present invention employs a video-to-scalar transformation. The details of this transformation are described below with respect to claims 23-25. To provide a useful signal for measuring behavior, the present invention employs another transformation, i.e., a scalar-to-behavioral metric transformation. The details of this transformation are described below with respect to claims 26 and 27. The remainder of the new claims are also discussed below.

1. Claim 23

New claim 23 is directed to a method for monitoring a biological process. The method comprises receiving image data of an object having one or more features. The image data corresponds to frames comprising a plurality of pixels. The method further comprises dividing each frame into one or more regions based on the one or more features and each region into one or more subregions and filtering the pixels in each subregion to provide a filtered output of pixels.

The video-to-scalar transformation described above is reflected in the remaining two steps of claim 23. Specifically, claim 23 recites "defining for each frame a first area within each subregion, said first area defined by one or more predetermined shape equations according to a shape of a feature to be monitored in the subregion" and "evaluating for each frame the number of filtered output of pixels in the first area for each subregion to transform the image data to a scalar feature signal for each subregion." Support for these steps is found in the specification and drawings including, without limitation, at page 10, line 1 to page 11, line 6.

What is important to emphasize here is that these two steps enable the conversion of a large amount of data into a scalar (single value) signal that is practical for analysis. First, a large amount of data can be ignored as artifact through the defining step, because the shape equation defining the first area is tailored to the shape of the feature to be monitored. This dramatically improves the signal to noise ratio. Second, the remaining data is transformed into a scalar signal by

simply evaluating the number of pixels in the defined first area as recited in the evaluating step. This is not computationally burdensome and produces a signal that is practical for analysis.

The prior art cited by the Examiner in rejecting the original claims fails to disclose or suggest at least these two steps of new claim 23. In the Office Action, the Examiner has cited to Prokoski's disclosure of a feature extractor 112 and thermal analyzer 114 at Col. 22, line 60 to Col. 23, line 12. (See also Figs. 15 and 16 of Prokoski.) However, there is no disclosure in the cited section at all of how the features are extracted or compared to previous extractions. There is no certainly no disclosure of the recited defining and evaluating steps of claim 23. Indeed, the description of Fourier and Markov transformations in Prokoski suggests a heavy computation analysis that is the opposite of the present invention.

The Examiner also cited Molander in rejecting the original claims. (See Office Action at page 7.) Molander discloses taking an image and applying a Gabor filter to identify "blobs." The blobs are then applied to a masking process. The masking process is described in paragraphs 0037-0039 and shown at steps S15 and S16 in Fig. 3. Specifically, each blob is masked with three different circle-shaped masks. For each mask, the edge contact is determined as well as the pixel intensity inside the mask. The blob with the highest score from at least two masks is considered the best candidate for a pair of eyes. Thus, as with Prokoski, Molander discloses a heavy computational approach (employing edge map matching and complex decision making) to extract a feature. There is simply no disclosure of transforming the image data to a scalar (single value) signal as recited in claim 23.

2. Claims 24 and 25

Claims 24 depends from claim 23 and further describes the defining and evaluating steps of claim 23. Specifically, claim 24 recites an additional defining step defining a second area adjacent to the first area. It also recites that the evaluating step comprises "determining for each frame the difference between the number of filtered output pixels in the first area and the number of filtered output pixels in the second area and outputting a value of the difference to produce the scalar

feature signal for each subregion." Support for this claim is found in the specification and drawings including, without limitation, at page 10, line 1 to page 11, line 6.

Prokoski, as the Examiner concedes, does not disclose or suggest comparing a filtered output of pixels in two different areas. (See Office Action at page 7.) Molander describes comparing the intensity of pixels inside and outside of the mask at paragraph 0038. However, Molander does not use the difference determination in the manner recited in claim 24. Claim 24 recites "outputting a value of the difference to produce the scalar feature signal for each subregion." Instead, Molander merely checks to see if the difference exceeds a threshold to determine the presence of an edge. (See paragraph 0038). Thus, there is no disclosure of transforming the image data into a scalar signal as recited.

Claim 25 recites that the parameters of the shape equations can be modified based on the detected changes in the feature to be monitored. Support for this claim is found in the specification and drawings including, without limitation, at page 6, line 11-13 and page 13, line 27-30. It is believed that none of the cited references in rejecting the original claims discloses the recitation of claim 25.

3. Claims 26 and 27

Claim 26 depends from claims 23 and 24 and is directed to the second transformation described above, i.e., the scalar-to-behavioral transformation. The transformation operates on the one or more scalar feature signals to produce one or more signals that more closely correlate to behavior. This is achieved by using a function, such as Eq. 1 in the specification, with a fractional multiplier that provides an accurate assessment of behavioral significance. (See specification at page 12, line 4 to page 13, line 8.)

Claim 26 recites "transforming each scalar feature signal to produce a behavior indicating output signal for each subregion, said step of transforming comprising setting the value of the behavior indicating output signal to the value of the scalar feature signal at a first time if the value of the scalar feature signal at the first time is equal to or greater than the value of the behavior indicating output signal at a time preceding the first time and reducing the value of the behavior

indicating output signal by a fraction if the value of the scalar feature signal at the first time is less than the value of the behavior indicating output signal at a time preceding the first time." Support for this claim is found in the specification and drawings including, without limitation, page 12, line 4 to page 13, line 8.

None of the references cited in rejecting the original claims discloses such a transforming step. At page 8 of the Office Action, the Examiner refers to Shiffer's use of a pixel motion tracker at Col. 9, lines 49-53. However, the discussion of pixel motion tracker in Shiffer does not at all describe the current recitations of claim 26.

Furthermore, none of the references used in rejecting the claims discloses both the transforming step of claim 26 *and* the defining and evaluating steps of claims 23 and 24 from which claim 26 depends.

Claim 27 further recites that the fraction of claim 26 is a function of time with its parameters determined by the biological process. Support for this claim is found in the specification and drawings including, without limitation, at page 7, lines 6-9 and page 13, line 27-30.

4. Claims 28-33

New claims 28-33 further recite additional steps such as obtaining a composite signal based on combining the behavior indicating output signals of claim 26 and correlating the composite signal with one or more independent measures of the biological process. Support for these claims is found in the specification and drawings including, without limitation, at page 7, lines 4-13 and page 13, lines 9-30. It is believed that these claims are in condition for allowance.

5. Claim 34

New claim 34 depends from claim 23 and recites "acquiring image data via computerized microscopy" and "wherein the biological process is microscopic at the tissue, cellular or subcellular level." Support for this claim is found in the specification and drawings including, without limitation, at page 16, lines 10-15. The cited lines describe the use of computerized microscopy

which can be used for analyzing processes at the tissue, cellular or subcellular level and controlling such processes.

The Examiner cited Prokoski as disclosing "micro-movements." (See Office Action at page 4, second full paragraph, and Prokoski at Col. 14, lines 2-5.) This disclosure, according to the Examiner, teaches the monitoring of a microscopic biological process. The "micro-movements" described in Prokoski are not microscopic, but rather small facial movements. Prokoski is thus directed to macroscopic biological processes and, consistent with its direction, it does not disclose or suggest the use of computerized microscopy to monitor a microscopic biological process. Accordingly, Applicant respectfully submits that claim 34 is in condition for allowance.

6. Claims 35-40

Claims 35-40 depend from claim 23. These claims are similar to original claims 3-8. Applicant respectfully submits that these claims are in condition for allowance for at least the reasons described above with respect to claim 23.

7. Claims 41-58

New claims 41-58 are apparatus claims corresponding to new method claims 23-40. Applicant respectfully submits that these claims are in condition for allowance for at least the reasons set forth above with respect to claims 23-40.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

If, for any reason, the Examiner finds the application other than in condition for allowance, Applicant requests that the Examiner contact the undersigned attorney at the Los Angeles telephone number (213) 892-5630 to discuss any steps necessary to place the application in condition for allowance.

In the unlikely event that the transmittal letter is separated from this document and the Patent Office determines that an extension and/or other relief is required, Applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 03-1952** referencing Docket No. 529742000100.

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Respectfully submitted,

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